PANDwriting: An Accessible, High-Sensitivity Parkinson's and Alzheimer's Screening System Using Vision-Based Handwriting Kinematic Analysis and Machine Learning

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PANDwriting is a novel screening system for neurodegenerative diseases (NDs), particularly targeted to increase Alzheimer's Disease (AD) and Parkinson's Disease (PD) diagnostic access in low-income areas and resource-poor health systems globally. PANDwriting uses only a smartphone camera to record videos of patients performing handwriting tasks, which are then analyzed using perspective transformation matrices and 'recurrent region of interest feature matching' to extract kinematic information and quantify fine motor ability. This system pioneers vision-based fine motor movement analysis, achieving a mean position error of less than 0.5 mm, and speed and acceleration errors below 1.1% (n=216). The PaHaW dataset was then utilized to demonstrate the effectiveness of this system in identifying diseased patients, training an ensemble classifier consisting of a neural network, support vector machine, and random forest with 10-fold cross-validation. This system achieved a sensitivity of 79% in detecting PD patients based on handwriting data (n=75), and by incorporating proof of concepts for pen pressure estimation (<9% error, n=41,391), as well as hand pose and other video metrics, this sensitivity is estimated to surpass 90%. The developed PANDwriting system demonstrates that accurate kinematic data of fine motor movements can be collected with computer vision and leveraged for ND screening with machine learning. Furthermore, this versatile system can be leveraged to screen not just for NDs, but also any health conditions with biomarkers displayed in fine motor movements. Due to its accessibility and broad data collection ability, the PANDwriting system has potential to enable population-wide screening for NDs and ultimately improve treatment outcomes for millions worldwide.

Awards Won:
Third Award of $1,000